

Appendix G

Toxicity Reference Value for Each Contaminant/Functional Group

Table G-1. Summary of toxicity reference values (TRVs in mg/kg-day) for mammalian functional groups.

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Aluminum (Mouse -NOAEL)	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	4.83	4.83
Aluminum chloride (Cow - NOAEL)	1.2	1.2	1.2	1.2	0.80	0.80	0.80	0.80	0.80	0.80
Aluminum nitrate (Rabbit - NOAEL)	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04
Aluminum nitrate (Rat -TDL)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	11.25	11.25
Aluminum hydroxide (Rat -AEL)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.69	0.69
Aluminum sulfate (Sheep - NOAEL)	0.61	0.61	0.61	0.61	0.41	0.41	0.41	0.41	0.41	0.41
Arsenic (Mouse-LOAEL)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.08	0.08
Arsenic (Rat)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.19	0.19
Arsenic (Sheep)	0.064	0.064	0.064	0.064	0.043	0.043	0.043	0.043	0.043	0.043
Arsenic (Sheep)	0.097	0.097	0.097	0.097	0.064	0.064	0.064	0.064	0.064	0.064
Barium (Rat -NOAEL)	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	1.02	1.02
Barium (Dog -FEL-1)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.36	0.73
Benzo(a)pyrene (Rat -Cancer)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Beryllium (Rat -NOAEL)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.33	0.33
Chromium (VI) (Dog -NOAEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.15
Chromium (VI) (Mouse -FFL)	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	4.92	4.92
Cobalt (Dog -LOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.42
Cobalt (Rat -NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21
Copper (Cow -NOAEL)	0.92	0.92	0.92	0.92	0.61	0.61	0.61	0.61	0.61	0.61
Copper (Mink -NOAEL)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	1.95	0.65	0.65
Copper (Rat -NOAEL)	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	2.75	2.75
Fluoride (Mink -NOAEL)	10.46	10.46	10.46	10.46	10.46	10.46	10.46	31.37	10.46	10.46
Lead (Cattle -NOAEL)	0.08	0.08	0.08	0.08	0.06	0.06	0.06	0.06	0.06	0.06

[illegible][illegible]

Table G-2. (continued).

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Table G-2. (continued).

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COPC: Aluminum nitrate nonahydrate CAS 7784-27-2
(as aluminum chloride)

Test Organisms: Cow (Herbivore, Order-Artiodactyla)

Exposure Medium: Oral in diet

Test Endpoint: NOAEL

Reference: Valdivia, R., C.B. Ammerman, C.J. Wilcox, and P.R. Henry, 1978. Effect of dietary aluminum on animal performance and tissue mineral levels in growing steers. Journal of Animal Science, 47:1351, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

QCE: 28.9 mg/kg-day 1200mg/kg food* 6.33kg
food/day(cited)/262kgBW (cited)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only males tested.
Q ₁	1	1	1	Ecologically relevant endpoints
Q ₂	2	2	2	Subchronic study (84 days)
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages not examined. NOAEL established. Test organisms exposed to AlCl ₃ ·6H ₂ O
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	28.9	28.9	28.9	QCE = quantified critical endpoint
TRV	2.41	1.20	0.80	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.41	Test organism is in the same order and trophic level as the functional group members	none
2	1.20	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.80	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Aluminum nitrate nonahydrate CAS 7784-27-2
(as aluminum nitrate)

Test Organisms: Rabbit (Herbivore, Order-Lagomorpha)
Exposure Medium: Oral in diet
Test Endpoint: NOAEL
Reference: Nekipelov, M.K, 1966. Hygienic standard for aluminum nitrate in water basins. Hyg. Sanit. (USSR), 31:204, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

QCE: 1.0 mg/kg-day (as aluminum nitrate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic study (6 months)
Q ₃	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. NOAEL established. Test organisms fed Al(NO ₃) ₂ .
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1	1	1	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.04	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:**Aluminum nitrate nonahydrate** CAS 7784-27-2**Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Oral in diet

Test Endpoint:

TDLo - Developmental abnormalities, including death, in offspring

Reference:Paternain, J.L., J.L. Domingo, J.M., Llober, J. Corbella, 1988, "Embryotoxic and Teratogenic Effects of Aluminum Nitrate in Rats Upon Oral Administration", *Teratology*, 38:253-257**QCE:**

180 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only ten pregnant rats for each dose, and no males, were tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic study (dose given days 6 to 14 of pregnancy)
Q ₃	2	2	2	LOAEL
U	2	2	2	Limited information but reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	180	180	180	QCE = quantified critical endpoint
TRV	22.50	11.25	7.50	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	22.50	Test organism is in the same order and trophic level as the functional group members	none
2	11.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	7.50	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Aluminum nitrate nonahydrate CAS 7784-27-2
Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Oral in diet
Test Endpoint: Adverse effect level - significantly retarded growth in young
Reference: Thurston, H., G.R. Gilmore, and J.E. Swales, 1972. Aluminum retention and toxicity in chronic renal failure, The Lancet, 1: 881-883
QCE: 22.0 mg/kg-day (as aluminum hydroxide) (8 mg/rat-day)/0.36kgBW

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	3 to 4-week old animals tested, sex not specified.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration (4 weeks)
Q ₃	2	2	2	AEL-reduced growth rate, increased bone Al concentrations
U	2	2	2	Sensitive life stage examined. No NOAEL established. Test animals exposed to aluminum hydroxide.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	22.0	22.0	22.0	QCE = quantified critical endpoint
TRV	1.38	0.69	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.38	Test organism is in the same order and trophic level as the functional group members	none
2	0.69	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

*BW and ingestion rate specified in the article

COPC: Aluminum nitrate nonahydrate CAS 7784-27-2
Test Organisms: Sheep (Herbivore, Order-Artiodactyla)
Exposure Medium: Oral in diet
Test Endpoint: NOAEL
Reference: Thompson, A, S.L. Hansard, and M.C. Bell, 1959. The influence of aluminum and zinc upon the absorption and retention of calcium and phosphorus in lambs. *Journal of Animal Science*, 18:187
QCE: 22.1 mg/kg-day (900 mg/kg)*(0.907 kg/day)/37 kg

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Four animals tested/dosage, sex not specified.
Q ₁	1	1	1	Ecologically relevant endpoints
Q ₂	2	2	2	Subchronic study (14 days)
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Old study where no reproductive endpoints or sensitive life stages examined. NOAEL established. Test organisms fed aluminum sulfate.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	22.1	22.1	22.1	QCE = quantified critical endpoint
TRV	1.23	0.61	0.41	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.61	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.41	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Arsenic CAS 7740-38-2 don't use can't find

Test Organisms: Domestic sheep (Herbivore, Order-Artiodactyla)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Eisler, R. 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12):92pp

QCE: 2.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q ₁	1	1	1	Relevant effect.
Q ₂	2	2	2	Subacute duration.
Q ₃	1	1	1	NOEL endpoint.
U	3	3	3	Secondary source, only one dose level.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	.130	.064	.043	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.130	Test organism is in the same order and trophic level as the functional group members	none
2	.064	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	.043	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Arsenic CAS 7778-43-0 Need to get this study

Test Organisms: Mice (Omnivore, Order-Rodentia)

Exposure Medium: Diet as sodium arsenate or sodium arsenite

Test Endpoint: LOAEL

Reference: Schroeder, H.A., and M. Mitchner, 1971. *Toxic effects of trace elements on the reproduction of mice and rats*. Arch. Environ. Health. 23:102-106.

QCE: 1.25 mg/kg-day ((5 mg As/L H₂O)*(0.0075 L/day))/(0.003kg BW)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	3 generations, however only one dosage
Q ₁	1	1	1	Declining litter sized with each successive generation
Q ₂	1	1	1	Chronic study.
Q ₃	2	2	2	LOAEL
U	2	2	2	Only one dose level, no NOAEL established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	0.16	0.08	0.052	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.16	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.052	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC:**Arsenic CAS 7778-43-0****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet as sodium arsenate or sodium arsenite

Test Endpoint:

NOAEL

Reference:Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147**QCE:**

3.1mg/kg-day (62.5 mg/kg food)*(0.0189kg/day)/(0.382 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	300 weanling Data do not show a good dose-response curve low-dose range.
Q ₁	1	1	1	Levels of 62.5 ppm As as arsenite and 125 ppm As as arsenate did not cause common bile duct enlargement and did not affect survival. Weight was slightly reduced in females at the 62.5 ppm As as arsenite.
Q ₂	1	1	1	Chronic study.
Q ₃	1	1	1	NOAEL using lowest NOAEL from either arsenite or arsenate
U	2	2	2	Good overall design, but no reproductive studies in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.1	3.1	3.1	QCE = quantified critical endpoint
TRV	0.78	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.78	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.27	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

COPC: Barium CAS 7440-39-3

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Oral

Test Endpoint: FEL-1 LD-100

Reference: Venugopal, B., and T.D. Luckey, 1978, The Toxicity of Metals in Mammals, Plenum Press, New York.

QCE: 59 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information (secondary source)
Q ₁	1	1	1	Endpoint expected to be ecologically significant
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	Lethal endpoint
U	3	3	3	Acute study; no other information (secondary source)
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	0.73	0.36	0.24	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.73	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.36	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.24	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Barium CAS 7440-39-3
Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Water
Test Endpoint: NOAEL
Reference: Perry, H.M. et al. 1989, "Hypertension and associated cardiovascular abnormalities induced by chronic barium feeding," Journal of Toxicology and Environmental Health, 28(3):373-388.
Kopp, S.J. et al. 1985, "Cardiovascular dysfunction and hypersensitivity to sodium pentobarbital induced by chronic barium chloride ingestion," Toxicology and Applied Pharmacology, 77(23):303-314.

QCE: .051mg/kg-day (1 mg/L)*(0.022L/day)/0.435kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q ₁	1	1	1	Although endpoint examined (increased blood pressure at higher doses) could occur in ecological receptors, the absence of any effects on growth and longevity at any dose argues against its ecological relevance. But at the NOAEL dose, no hypersensitivity was observed.
Q ₂	1	1	1	Chronic study (16 months)
Q ₃	1	1	1	NOAEL endpoint
U	1	1	1	Concordant results in several detailed studies
Total AF	0.50	1.00	1.50	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.051	.051	.051	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	none
2	0.05	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.03	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*BW given by an earlier Perry article, ingestion rate specified in the article

**note-10ppm had some adverse effects such as an increase in blood pressure and tissue concentration.

COPC: Benzo(a)pyrene (BaP) CAS 50-32-8
Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Oral (gavage solution)
Test Endpoint: Cancer
Reference: Brune et al., 1981, "Investigation of the tumorigenic response to benzo(a)pyrene in aqueous caffeine solution applied orally to Sprague-Dawley rats," *Journal of Cancer Research and Clinical Oncology*, 102(2): 153-157.
QCE: 0.11 mg/kg-day Specified and adjusted for treatment schedule. (5 times/week)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males and females tested (68/dose). No juveniles tested.
₁	.5	.5	.5	Cancer is endpoint measured
Q ₂	1	1	1	Long-term study
Q ₃	3	3	3	Cancer endpoint
U	2	2	2	Adequate study but no reproductive endpoints tested and statistical evaluation of data not reported. Other studies support the conclusion that BaP causes cancer in rodents.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.11	.11	.11	QCE = quantified critical endpoint
TRV	0.02	0.01	0.01	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.02	Test organism is in the same order and trophic level as the functional group members	none
2	.01	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	.01	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Beryllium (Beryllium sulfate) CAS 7440-41-7

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Water

Test Endpoint: NOAEL

Reference: Schroeder, H.A., and M. Mitchner, 1975, *Life-Term Studies in Rats: Effects of Aluminum, Barium, Beryllium and Tungsten*, J. Nutr. 105: 421-427.

QCE: 0.66mg/kg-day (5mg/L water)*(0.046L/day)/0.35 kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q ₁	1	1	1	No endpoint observed
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.66	0.66	0.66	QCE = quantified critical endpoint
TRV	0.66	0.33	0.22	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.66	Test organism is in the same order and trophic level as the functional group members	none
2	.33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	.22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*Ingestion rate specified by EPA (EPA, 1985a).

COPC: Chromium (VI) CAS 7440-47-3

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Water

Test Endpoint: NOAEL

Reference: Steven et al. (1976) cited in Eisler (1986)
 Anwar, R.A., et al., 1961, "Chronic Toxicity Studies. Part III. Chronic Toxicity of Cadmium and Chromium in Dogs", *Archives of Environmental Health*, 3:456-460
 Steven, J.D. et al., 1976, *Effects of Chromium in the Canadian Environment*, RCC No. 15017, National Resources Council, Ottawa, Canada.

QCE: 0.30 mg/kg-day 11.2 mg/L*(3.1mL**/100g-day)*8730g*1L/1000mL/8.73 Kg BW

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of female dogs only. No males tested.
Q ₁	1	1	1	No endpoint observed
Q ₂	1	1	1	Chronic duration (4 years)
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint studied, but good duration of testing.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.30	0.30	0.30	QCE = quantified critical endpoint
TRV	0.15	0.08	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.05	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**Water consumption information is from the Dames and Moore animal data chart.

COPC: Chromium(VI)CAS 7440-47-3

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Water

Test Endpoint: FEL-r

Reference: Trivedi, B., et al., 1989, "Embroyotoxicity and fetotoxicity of orally administered hexavalent chromium in mice," Reproductive Toxicology, 3(4);275-278.

QCE: 59 mg/kg-day Specified from 1.76 mg/mouse-day and a BW of .030 kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, variability assessed appropriately and not high.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic exposure duration
Q ₃	3	3	3	FEL endpoint - fetal development harmed
U	2	2	2	Well designed study, appropriate endpoints well characterized, but no NOAEL identified.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	9.83	4.92	3.28	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.83	Test organism is in the same order and trophic level as the functional group members	none
2	4.92	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.28	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Cobalt CAS 7440-48-4

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: LOAEL

Reference: Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE: 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q ₁	0.5	0.5	0.5	Endpoint of questionable ecological significance
Q ₂	2	2	2	Subchronic duration (4 weeks)
Q ₃	2	2	2	LOAEL endpoint (increased red blood cell count)
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Cobalt CAS 7440-48-4
Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.
 Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

QCE: 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q ₁	1	1	1	Endpoint of relevant ecological significance
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Copper CAS 7440-50-8 Don't use very poorly designed study

Test Organisms: Cattle (Herbivore, Order-Artiodactyla)

Exposure Medium: Drenched with a daily solution of Cu as Copper sulphate

Test Endpoint: NOAEL

Reference: Cunningham, I.J., 1946, *The Toxicity of Copper to Bovines*, N.Z.J. Sci., Technol, 27A:372.

QCE: 1.1 mg/kg-day (300mg/cow-day**)*(1 cow/600lb)*(1 lb/0.453 kg)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Two Jersey heifer calves, seven months old and two adult cows in calf were used in the experiment.
Q ₁	0.1	0.1	0.1	Health, growth and condition, livers had elevated copper levels.
Q ₂	1	1	1	Study was chronic (12–16 months)
Q ₃	1	1	1	NOAEL
U	3	3	3	Poorly designed study with limited samples (only 1 animal per level of contaminant). Sensitive population (young calves) studied, but limited information is provided.
Total AF	0.6	1.2	1.8	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.1	1.1	1.1	QCE = quantified critical endpoint
TRV	1.8	0.92	0.61	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.8	Test organism is in the same order and trophic level as the functional group members	none
2	0.92	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.61	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Copper CAS 7440-50-8
(copper sulfate)

Test Organisms: Mink (Carnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Aulerich, R.J., et al., 1982, *Effects of Supplemental Dietary Copper on Growth, Reproductive Performance and Kit Survival of Standard Dark Mink and the Acute Toxicity of Copper to Mink*, Journal of Animal Science, 55(2):337-43.

QCE: 11.71 mg/kg-day 25mg/kg*0.175kg fed/day/1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Group sizes were small relative to observed variation in responses
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic exposure
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Parameters observed were relevant but not exhaustive
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	11.7 1	11.7 1	11.7 1	QCE = quantified critical endpoint
TRV	1.95	0.98	0.65	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.95	Test organism is in the same order and trophic level as the functional group members	M322
2	.98	Test organism is in a different order and same trophic level from the functional group members	none
3	0.65	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC: **Copper CAS 7440-50-8**

Test Organisms: Rat (F334/N) (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: NOAEL

Reference: Hebert, C.D., et al., 1993, *Subchronic Toxicity of Cupric Sulfate Administered in Drinking Water and Feed to Rats and Mice, Fundamentals and Applied Toxicology*, 21:461-475.

QCE: 66 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Males appeared to be more sensitive than females
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic exposure
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Thorough and well-designed study, but subchronic duration prevented evaluation of long-term effects, e.g., development of tolerance as reported by others.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	66	66	66	QCE = quantified critical endpoint
TRV	5.50	2.75	1.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.50	Test organism is in the same order and trophic level as the functional group members	none
2	2.75	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Fluoride CAS # 16984-48-8

Test Organisms: Mink (Carnivore, Order-Carnivora)

Exposure Medium: Oral in diet (NaF)

Test Endpoint: NOAEL

Reference: Aulerich, R.J., et al., 1987. "Chronic toxicity of Dietary Fluorine in Mink", *J. Animal. Sci.* 65:1759-1767

QCE: 31.37 mg/kg-day (229mg/kg-day)*(0.137kg/day)/1kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females (60 each) tested.
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic (382-days)
Q ₃	1	1	1	NOAEL
U	1	1	1	Good design, looked at sensitive life stages and reproduction
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	31.3 7	31.3 7	31.3 7	QCE = quantified critical endpoint
TRV	31.3 7	15.6 9	10.4 6	Toxicity Reference Value = QCE/Total AF

	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	31.37	Test organism is in the same order and trophic level as the functional group members	M322
2	15.69	Test organism is in a different order and same trophic level from the functional group members	none
3	10.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

COPC: Lead CAS 7439-92-1 Don't use this study

Test Organisms: Cow (Bos spp., Herbivore, Order-Artiodactyla)

Exposure Medium: Diet (in hay and grain)

Test Endpoint: LD50

Reference: Zmudski, J., et al., 1983, *Lead Poisoning in Cattle: Reassessment of the Minimum Toxic Oral Dose*, Bull. Environ. Contam. 30:435-441.

QCE: 2.7 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	22 Holstein males (9-12 weeks old) weighting approx. 55 kg. were tested
Q ₁	1	1	1	No endpoint observed
Q ₂	2	2	2	Subchronic study
Q ₃	2	2	2	LD50 endpoint, death w/in 20 d if on milk diet
U	2	2	2	Reasonable design, but no reproductive endpoints examined. However, pregnant ewes given 3 mg/kg daily did not produce adverse effects (DeMayo, et. al., 1982).
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.7	2.7	2.7	QCE = quantified critical endpoint
TRV	0.17	0.08	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.17	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.06	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Lead CAS 7439-92-1 Can't find this one of course

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: LOAEL Not specified

Reference: DeMayo, A., et al.. 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305
 Rice, D.C., 1985, *Chronic Low-Lead Exposure from Birth Produces Deficits in Discrimination Reversal in Monkeys*, Toxicol. Appl. Pharmacol. 77:201-210.

QCE: 0.32 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	Endpoint not specified
Q ₂	1	1	1	Chronic study
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Limited information. However, a chronic study in monkeys reported a similar LOAEL (0.1 mg/kg/day) for CNS effects (Rice, 1985).
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	.0267	0.0133	0.0089	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0267	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.0133	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.0089	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC:	Lead CAS # 7439-92-1
Test Organisms:	Rat (Omnivore, Order-Rodentia)
Exposure Medium:	Oral in diet as lead acetate
Test Endpoint:	LOAEL
Reference:	Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of Lead Studies in Animals Carried Out at Haskell Laboratory: Two-Year Feeding Study and Response to Hemorrhage Study", In <i>Environmental Health Aspects of Lead: Proceedings, International Symposium</i> , D. Barth et al. (ed.) Commission of European Communities, pp 199-210
QCE:	8 mg/kg-day (100 mg/kg food)*(.028 kg/day)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	50 male and 50 female rats per dose level. Reproductive three generation (during critical life stage) study.
Q ₁	1	1	1	Mortality, # of tumors, weight gain, # of pregnancies, # of pups born alive, fertility index, gestation index, viability index or lactation index. Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic
Q ₃	1	1	1	NOAEL
U	1	1	1	Pb as lead acetate was fed for a three-generation six-litter study at multiple dosages (0, 10, 50, 100, 1000, 2000 ppm). At 1000 and 2000 ppm dietary Pb, the average weight of weanling rats was slightly decreased. At 10 ppm stippled cells were increased. A decrease in ALAD activity was seen at 50 ppm (however these are not considered adverse effects). 100 ppm Pb is considered the NOAEL.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	8	8	8	QCE = quantified critical endpoint
TRV	8	4	2.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8	Test organism is in the same order and trophic level as the functional group members	none
2	4	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

*ingestion rate and BW taken from data table for animals

COPC: Lead CAS 7439-92-1
Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Drinking Water (Pb as lead acetate)
Test Endpoint: LOAEL Pup malformations
Reference: Kimmel, C.A., et al., 1980, *Chronic Low Level Lead Toxicity in the Rat. I. Maternal Toxicity and Perinatal Effects*, Toxicol. Appl. Pharmacol. 56:28-41.
QCE: 0.36 mg/kg-day Specified (5 mg/l in water, rat water intake .025 L/day/0.35 kg BW).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	#'s of animals in control and Pb groups ranged from 60 to 148 during the pregnancy period, from 24 to 75 pre-pregnancy, and 6 to 13 litters during post pregnancy. However, significant variation between replicates was seen, and only females examined.
Q ₁	1	1	1	Food % water consumption, reproductive success, and concentrations in selected tissue. Ecologically relevant endpoints.
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL (although Pb concentrations in blood were increased in females exposed to 5 ppm toxicity was not seen at this level)
U	1	1	1	Good design, studied reproductive effects. Weanling female rats were exposed through mating, gestation and lactation. Various dose levels (0, 5, 25, 50 ppm) studied and LOAEL established. Other studies support findings. (DeMayo et al., 1982).
Total AF	2	4	8	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.36	0.36	0.36	QCE = quantified critical endpoint
TRV	0.18	0.09	0.045	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.18	Test organism is in the same order and trophic level as the functional group members	none
2	0.09	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.045	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

DeMayo, A., et al.. 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305

COPC: Magnesium CAS 7439-95-4

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Oral in diet

Test Endpoint: Minimum lethal dose (MLD)

Reference: Venugopal, B. and T.D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press

QCE: 230 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	3	3	3	Duration of exposure unknown
Q ₃	3	3	3	FEL - lethality.
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. No NOAEL established
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	230	230	230	QCE = quantified critical endpoint
TRV	2.8	1.4	0.95	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.8	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.4	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.95	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: Magnesium CAS 7439-95-4

Test Organisms: Sheep (Herbivore, Order-Artiodactyla)

Exposure Medium: Oral in drinking water

Test Endpoint: NOAEL

Reference: Pierce, A.W. 1959. Studies on salt tolerance of sheep. II. The tolerance of sheep for mixtures of sodium chloride and magnesium chloride in the drinking water. Australian Journal of Agricultural Research, 10:725

QCE: 24 mg/kg-day * 1300mg/day/55 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	42 3-6 year old animals tested.
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic exposure (16 months).
Q ₃	2	2	2	LOAEL - loss of weight
U	2	2	2	No reproductive endpoint or sensitive life stage examined. No NOAEL established. Test organisms exposed to MgCl.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	24	24	24	QCE = quantified critical endpoint
TRV	12	6	4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12	Test organism is in the same order and trophic level as the functional group members	none
2	6	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	4	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

* Value might need to be checked. NAS book stated 4 for it's LOAEL

**Magnesium intake and BW specified in article

COPC: Manganese CAS 7439-96-5

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Diet

Test Endpoint: LOAEL Decreased testosterone levels, delayed maturation of reproductive function

Reference: Laskey, J.W., Rehnberg, G. L., and Hein, J.F., 1982, *Effects of Chronic Manganese (MN₃O₄) Exposure on Selected Reproductive Parameters in Rats*, *J. Toxicol. Environ. Health* 9: 677-687.
ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Manganese*, 1990.

QCE: 13 mg/kg-day 350mg/kg food*0.0138kg/day/0.313kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, males, females and juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic study
Q ₃	2	2	2	LOAEL endpoint
U	1	1	1	Good design, reproductive endpoints examined and the study results consistent in mice.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	6.50	3.25	2.17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.50	Test organism is in the same order and trophic level as the functional group members	none
2	3.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:	Mercury (Organic)
Test Organisms:	Cattle (Herbivore, Order-Artiodactyla)
Exposure Medium:	Oral in diet
Test Endpoint:	NOAEL
Reference:	Herigstad, R.R., et al., 1972, "Chronic methylmercury toxicosis in calves. " J. Am. Vet. Med. Assoc. 160:173-182. (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC)
QCE:	0.1 mg/kg. body weight-day (Hg as methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Discussion found that the results were similar to other reported studies. However, limited number of animals.
Q ₁	1	1	1	Clinical signs, lesions, and tissue residues determined (associated with methyl mercury toxicity (MMT) in calves). Endpoint relevant.
Q ₂	2	2	2	Subchronic exposure (96 days)
Q ₃	1	1	1	NOAEL
U	3	3	3	Small number of animals, 5 male Holstein-Friesian calves. No reproductive endpoint or sensitive life stage examined. Test chemical is methylmercury. NOAEL & LOAEL established. However only 1 animal per level tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.1	0.1	0.1	QCE = quantified critical endpoint
TRV	0.008	0.004	0.003	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.008	Test organism is in the same order and trophic level as the functional group members	none
2	0.01	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.003	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: Mercury (Inorganic)
Test Organisms: Mouse (Omnivore, Order-Rodentia)
Exposure Medium: Oral in drinking water
Test Endpoint: NOAEL
Reference: Schroeder and Mitchener, 1975. "Life-term effects of mercury, methylmercury and nine other trace metals on mice" *J. Nutr.* 105:452
QCE: 0.68 mg/kg-day Calculated 5 ppm Hg as mercuric chloride*.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. At 5 ppm longevity tended to decrease in males and increase in females.
Q ₁	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevities
Q ₂	1	1	1	Lifetime exposure
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. 5 ppm Hg as mercuric chloride in the basal drinking water. Only one dose tested and no LOAEL established.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.17	0.09	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.17	Test organism is in the same order and trophic level as the functional group members	none
2	0.09	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.06	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

* [(5 mg Hg/L water)*((0.0051 L water/day**)/0.0373 kg BW]

Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA 1993) $WI=0.099BW^{0.9}$

COPC: Mercury (Organic)
Test Organisms: Swine (Omnivore, Order-Artiodactyla)
Exposure Medium: Oral in diet (organic form methylmercuric chloride CH₃HgCL)
Test Endpoint: NOAEL
Reference: Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977. "Effect of varied dietary levels and forms of mercury on swine" J. Anim. Sci. 45:279-285.
QCE: 0.16 mg/kg-day specified 5 ppm [(5 mg/kg)x(2.5kg/day)/80 kg BW*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at .5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q ₁	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q ₂	2	2	2	Subchronic exposure (exposure thru breeding and birthing, however estimated at less than 50% of the total lifespan of a pig)
Q ₃	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined. LOAEL was established, however, different between NOAEL and LOAEL levels is great.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.16	0.16	0.16	QCE = quantified critical endpoint
TRV	0.04	0.02	0.01 3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.04	Test organism is in the same order and trophic level as the functional group members	None
2	0.02	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.013	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

*Ingestion rate from allometric equation , BW from study.

COPC: Mercury (Organic) CAS 7439-97-56
Test Organisms: Cat (Carnivore, Order-Carnivora)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Charbonneau, S.M., et al., 1976. *Chronic Toxicity of Methylmercury in the Adult Cat*, Interim Report, Toxicology, 5(1976):337-349.
QCE: 0.02 mg/kg-day Specified -either in naturally contaminated fish (methylmercury) or added to diet as methylmercuric chloride.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Each test group consisted of 8 random-bred domestic cats, 4 males and 4 females. Not rigorously examined, but no large variations within groups were evident
Q ₁	1	1	1	Food consumption, body weight, blood and urine changes and neurological status were examined. Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration (2 years)
Q ₃	1	1	1	NOAEL
U	2	2	2	Doses of 3, 8.4, 20, 46, 74 or 176 µg Hg/kg/day both in fish and as corn oil supplement. Older study, but thoroughly performed. Dose-response well-characterized for neurological effects, but reproductive effects not considered.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.02	.02	.02	QCE = quantified critical endpoint
TRV	0.005	0.0025	0.0017	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.005	Test organism is in the same order and trophic level as the functional group members	M322
2	.0025	Test organism is in a different order and same trophic level from the functional group members	M422A
3	.0017	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M422

COPC: Mercury (Organic) CAS 7439-97-56

Test Organisms: Mule Deer (Herbivore, Order-Artiodactyla)

Exposure Medium: Single dose

Test Endpoint: FEL-1 (LD-50)

Reference: Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report, 85(1.10).

QCE: 18 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	LD-50
U	3	3	3	Secondary source, little supporting information
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC:	Mercury (Organic) CAS 7439-97-56		
Test Organisms:	Pheasant (Omnivore, Order-Galliformes)		
Exposure Medium:	Diet		
Test Endpoint:	LOAEL-r	Reduced egg production, shell thickness, reduced hatchability	
Reference:	Fimreite, N., 1979, <i>Accumulation and Effects of Mercury on Birds</i>, Chapter 22 in <i>The biogeochemistry of Mercury in the Environment</i>, J.O. Nriagu, (ed.), Elsevier/North Holland Biomedical Press, New York.		
QCE:	.18 mg/kg-day	Specified	

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration (12 weeks)
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.18	.18	.18	QCE = quantified critical endpoint
TRV	.011	.005	.004	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.011	Test organism is in the same order and trophic level as the functional group members	none
2	.005	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	.004	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC:	Mercury (Organic) CAS 7439-97-56		
Test Organisms:	Rat (Omnivore, Order-Rodentia)		
Exposure Medium:	Oral (methylmercuric chloride in diet)		
Test Endpoint:	NOAEL	No effects on dams or offspring of female rats treated with methylmercury from weaning through parturition	
Reference:	Khera and Tabacova, 1973, <i>Effects of Methylmercuric Chloride on the Progeny of Mice and Rats Treated Before or During Gestation</i>, Food and Cosmetic Toxicology, 11:245-254.		
QCE:	.25 mg/kg-day	Specified	

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No prenatal effects were seen at 0.25 mg/kg-day however, an increased incidence of eye defects was seen. The study suggests that mercury was a contributory factor, in some unexplained way. This paper provides documentation of studies providing similar results.
Q ₁	1	1	1	Reproductive success measured, by #of pregnant mice, # of young per litter, weight of young, and postnatal survival. Ecologically relevant endpoint.
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	1	1	1	Immature females of the Wistar strain were randomized into 5 groups each consisting of 35 rats. Doses included 0, 0.002, 0.01, 0.05, or 0.25 mg Hg/kg/day as CH ₃ HgCl. The exposure was continued for sub-groups up to 192 days. Highest dose level was NOAEL for sensitive and relevant endpoint and LOAEL was not established.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.25	.25	.25	QCE = quantified critical endpoint
TRV	0.063	0.031	0.021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.063	Test organism is in the same order and trophic level as the functional group members	none
2	0.031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Naphthalene CAS 91-20-3

Test Organisms: Mouse (Omnivore, Order-Rodentia)

Exposure Medium: Oral

Test Endpoint: NOAEL

Reference: Shopp et al., 1984, "Naphthalene toxicity in CD-1 mice: General toxicology and immunotoxicology," *Fundamental and Applied Toxicology*, 4:406-419.

QCE: 5.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of male and females tested (40-112 of each sex), no juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Short-term (90-day) study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable design, but no reproductive endpoints or sensitive life stages examined. Existence of other subchronic studies to support the principal study not available.
	1	1	1	Not Applicable
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.3	5.3	5.3	QCE = quantified critical endpoint
TRV	6.63	3.31	2.21	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.63	Test organism is in the same order and trophic level as the functional group members	none
2	3.31	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.21	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Nickel CAS 7440-02-0
(nickel carbonate)

Test Organisms: Cow (Herbivore, Order-Artiodactyla)

Exposure Medium: Diet

Test Endpoint: NOAEL No effect on food intake or growth rate

Reference: O'Dell et al., 1970a, "Effect of Nickel Supplementation on the Production and composition of Milk, *J. Dairy Science*. National Academy of Sciences, 1980, *Mineral Tolerance of Domestic Animals*, Washington, DC

QCE: 4.1 mg/kg-day 1835mg/day/450 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	No endpoint observed
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Limited information or supporting studies.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.08	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

*BW an estimate until get actual article

**Other O'Dell articles may be more helpful, check the NAS book.

COPC: Nickel CAS 7440-02-0

Test Organisms: Dog (Omnivore, Order-Carnivora)

Exposure Medium: Diet

Test Endpoint: NOAEL Treatments had no effect on body weight gain

Reference: Ambrose, A.M. et al. 1976, *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs*, J. Food Sci. Technol. 13:181-187.

QCE: 25 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q ₁	1	1	1	No endpoint observed
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Limited information or supporting studies.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	12.5 0	6.25	4.17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12.50	Test organism is in the same order and trophic level as the functional group members	M422A
2	6.25	Test organism is in a different order and same trophic level from the functional group members	M422
3	4.17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC:	Nickel CAS 7440-02-0
Test Organisms:	Rat (Omnivore, Order-Rodentia)
Exposure Medium:	Diet
Test Endpoint:	NOAEL Treatments had no effect on body weight gain
Reference:	Ambrose, A.M., et al., 1976 <i>Long-Term Toxicologic Assessment of Nickel in Rats and Dogs</i> , <u>J. Food Sci. Technol.</u> 13:181-187. ABC (American Biogenics Corp.), 1986, <i>Ninety-Day Gavage Study in Albino Rats Using Nickel</i> , Draft Final Report submitted to Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709. RTI (Research Triangle Institute), 1987, <i>Two Generation Reproduction and Fertility Study of Nickel Chloride Administered to CD Rats in Drinking Water: Fertility and Reproductive Performance of the Po Generation (Part II of III) and F1 Generation (Part III of III)</i> , Final study report, Report submitted to Office of Solid Waste Management, U.S. EPA, Washington, DC.
QCE:	5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals.
Q ₁	1	1	1	No endpoint observed
Q ₂	1	1	1	Chronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Low survival in controls; however, another study by ABC, 1986 supports the 5 mg/kg/day NOAEL. A NOAEL for reproductive effects in a study by RTI (1987) was higher than the Ambrose study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	2.50	1.25	0.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.50	Test organism is in the same order and trophic level as the functional group members	none
2	1.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Thallium CAS 7440-28-0

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Oral in Diet

Test Endpoint: LOAEL Hair loss

Reference: Downs, W., Scott, J., Steadman, L., Maynard, E., 1960, "Acute and Sub-acute Toxicity Studies of Thallium Compounds", *Industrial Hygiene Journal*, pp399-406

QCE: 1.8mg/kg-day Specified (Average between 1-3 depending on the BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and female rats tested, no juveniles tested.
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL
U	2	2	2	Good design, a variety of compounds tested, reproductive endpoints no examined. Compound is thallium acetate.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Thallium CAS 7440-28-0**

Test Organisms: Rat (Omnivore, Order-Rodentia)

Exposure Medium: Drinking Water

Test Endpoint: FEL-r Reduced sperm motility, etc.

Reference: Formigli, L., et al., 1986, "Thallium-induced testicular toxicity in the rat," Environmental Research, 40(2):531-539.

QCE: .75mg/kg-day Daily intake of 0.27 mg/rat, each rat weighing an ave. of 0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well characterized effects, consistent results among groups
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	3	3	3	FEL based on reproductive effects
U	2	2	2	Only one dose, no NOAEL identified
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.75	.75	.75	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:**Vanadium (Vanadyl sulfate) CAS 7440-62-2****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

NOAEL Body weight gain

Reference:Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," Journal of Nutrition, 92:245-252.

ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.

QCE:

4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	1	1	1	Chronic duration
Q ₃	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: Aluminum nitrate nonahydrate CAS 7784-27-2
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Oral in diet
Test Endpoint: NOAEL
Reference: Miller, D. and R.R. Kifer, 1970. Effect of glutamic acid and antiacids on chick bioassay of protein quality of fish meals. *Poultry Science* 49:1327, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC
QCE: 3,500 mg/kg-day [as Al(OH)₃]

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	180 1-day old chicks tested
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study (19 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al(OH) ₃ .
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3,500	3,500	3,500	QCE = quantified critical endpoint
TRV	875.0	437.5	291.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	875.0	Test organism is in the same order and trophic level as the functional group members	none
2	437.5	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	291.7	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Aluminum nitrate nonahydrate CAS 13473-90-0
Test Organisms: Turkeys (Omnivore, Order-Galliformes)
Exposure Medium: Oral in diet
Test Endpoint: NOAEL
Reference: Cakir, A., T.W. Sullivan, and F.B. Mather, 1978. Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum. Poultry Science 57:498, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC
QCE: 324 mg/kg-day [as $\text{Al}_2(\text{SO}_4) \cdot 18\text{H}_2\text{O}$]

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study (28 days)
Q ₃	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to $\text{Al}_2(\text{SO}_4) \cdot 18\text{H}_2\text{O}$
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	324	324	324	QCE = quantified critical endpoint
TRV	40.5	20.3	13.5	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	40.5	Test organism is in the same order and trophic level as the functional group members	none
2	20.3	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	13.5	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Arsenic CAS # 7440-38-2
Test Organisms: Brown-headed cowbird (Insectivore, Order-Passeriformes)
Exposure Medium: NA
Test Endpoint: NOAEL
Reference: US Fish and Wildlife Service, 1969, Bureau of Sport Fisheries and Wildlife, Publication 74, pp 56-57
QCE: 2.46 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males only.
Q ₁	1	1	1	Mortality
Q ₂	1	1	1	Chronic (7 months)
Q ₃	1	1	1	NOAEL
U	1	1	1	Four dose levels- both a loael and noael established
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.46	2.46	2.46	QCE = quantified critical endpoint
TRV	1.23	0.62	0.41	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.62	Test organism is in a different order and same trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.41	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Arsenic CAS# 7440-38-2 Don't use
Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: NA
Test Endpoint: LD₅₀
Reference: National Academy of Sciences (NAS), 1977, *Arsenic*, Washington DC
QCE: 39 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with little supporting variation data.
Q ₁	1	1	1	Relevant effect.
Q ₂	3	3	3	Study duration was acute
Q ₃	3	3	3	QCEL is and LD ₅₀
U	3	3	3	Old study, secondary source
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	39	39	39	QCE = quantified critical endpoint
TRV	0.48	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.48	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Cobalt (cobalt chloride) CAS 7440-48-4
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Diet
Test Endpoint: LOAEL Increased mortality associated with *S. gallinarium* infection
Reference: Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.
QCE: 10.2 mg/kg-day 100 ppm in diet converted to dose using an ingestion rate* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic duration
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.64	0.32	0.21	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.64	Test organism is in the same order and trophic level as the functional group members	none
2	0.32	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.21	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

* Estimated as $0.0582 \text{ Wt}^{0.651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC:	Copper CAS 7440-50-8
Test Organisms:	Chicken (Omnivore, Order-Galliformes)
Exposure Medium:	Diet
Test Endpoint:	NOAEL
Reference:	Stevenson, M.H., and N. Jackson, 1981, "An Attempt to Distinguish Between the Direct and Indirect Effects, in the Laying Domestic Fowl, of Added Dietary Sulphate", <i>British Journal of Nutrition</i>, 46(1):71-76.
QCE:	1006 mg/kg-day [1408 mg Cu/day/1.4 kg BW]**

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Rather small group sizes (n=6)
Q ₁	1	1	1	Endpoints are body weight, food intake, egg production, hepatic metals concentrations. Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Subchronic exposure and small group sizes, but detailed characterization of relevant endpoints.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1006	1006	1006	QCE = quantified critical endpoint
TRV	83.83	41.92	27.89	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	83.83	Test organism is in the same order and trophic level as the functional group members	none
2	41.92	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	27.89	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Copper CAS# 7440-50-8
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Oral in diet (copper oxide)
Test Endpoint: NOAEL
Reference: Mehring, A.L., Jr., et al., 1960, "The Tolerance of Growing Chicken for Dietary Copper". *Poultry Sci.* 39:713-719
QCE: 47 mg/kg-day 570 ppm in diet converted by multiplying by 0.044 kg food/day ingestion rate, and dividing by 0.534kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Eleven dose levels during critical growth period, growth, mortality-for 10 weeks.
Q ₁	2	2	2	
Q ₂	1	1	1	Chronic exposure duration
Q ₃	1	1	1	NOAEL
U	2	2	2	
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	47	47	47	QCE = quantified critical endpoint
TRV	11.7 5	5.88	3.92	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.75	Test organism is in the same order and trophic level as the functional group members	none
2	05.88	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	3.92	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Fluoride CAS # 16984-48-8
Test Organisms: Screech Owl (Carnivore, Order-Strigiformes)
Exposure Medium: Oral in diet (NaF)
Test Endpoint: NOAEL
Reference: Patte, O.H., S.N. Wiemeyer, D.M. Swienford, 1988, "Effects of Dietary Fluoride on Reproduction in Eastern Screech Owls", *Arch. Environ. Contam. Toxicol.* 17:213-218
QCE: 7.8 mg/kg-day (56.5 mg/kg food)*(0.025kg/day)/0.181kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of animals (33 males and 33 females)
Q ₁	1	1	1	Ecologically relevant endpoint.
Q ₂	1	1	1	Chronic (5-6 months)
Q ₃	1	1	1	NOAEL
U	2	2	2	Good design, the study exposure included critical life stage, but only two dose levels.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.8	7.8	7.8	QCE = quantified critical endpoint
TRV	3.90	1.95	1.30	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.90	Test organism is in the same order and trophic level as the functional group members	none
2	1.95	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV333, AV342
3	1.30	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

**B.W from Dunning 1984

***Diet consumption from 1500g/pair/month from study

COPC: Lead CAS 7439-92-1 Don't use very short duration 10 days
Test Organisms: American Kestrel (Carnivore, Order-Falconiformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Survival, reproductive success
Reference: Hoffman, D.J., et al., 1985. *Biochemical and Hematological Effects of Lead Ingestion in Nestling American Kestrels (Falco Sparverius)*, Comparative Biochemistry and Physiology, 80C:431-439.
EPA, 1993, Wildlife Exposure Factors Handbook, Volumes I and II, EPA/600/R-93/187a and EPA/600/R-93/187b, Office of Research and Development, Washington, DC.
QCE: 25 mg/kg BW-day Specified*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of juveniles (40) but sex not specified and adults not tested
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but reproduction endpoint not tested
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	3.13	1.56	1.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.13	Test organism is in the same order and trophic level as the functional group members	AV310
2	1.56	Test organism is in a different order and same trophic level from the functional group members	AV322, AV333, AV342
3	1.04	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

*In the article they state that nestlings consume as much food as they weigh, therefore the ingestion rate and BW cancel each other out and 25 ppm goes to 25 mg/kgBW-day.

COPC: Lead CAS 7439-92-1
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Growth
Reference: Eisler, R., 1988, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, Fish and Wildlife Service. Bio. Rep. No. 14. April, 1985
QCE: 26 mg/kg-day 500 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Limited information. Dietary NOAEL appears consistent for a variety of species.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	1.44	0.72	0.48	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.44	Test organism is in the same order and trophic level as the functional group members	none
2	0.72	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.48	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Lead CAS 7439-92-1 Don't use single dose

Test Organisms: Mallard (Herbivore, Order-Anseriformes)

Exposure Medium: Single oral dose of lead shot

Test Endpoint: LOAEL Mortality, hematological effects

Reference: Dieter, M.P., and M.T. Finley., 1978. *Erythrocyte Gamma-Aminolevulinic Acid Dehydratase Activity in Mallard Ducks: Duration of Inhibition After Lead Shot Dosage*, J. Wildl. Manage. 42:621-625.

QCE: 151 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	30 males and 30 females tested, but no juveniles
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	3	3	3	Acute study
Q ₃	3	3	3	Lethality endpoint
U	2	2	2	Reasonable design
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	151	151	151	QCE = quantified critical endpoint
TRV	4.19	2.10	1.40	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.19	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	2.10	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	1.40	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Lead (Trimethyllead) CAS 7439-92-1**

Test Organisms: European Starling (Insectivore, Order-Passeriformes)

Exposure Medium: Capsule

Test Endpoint: LOAEL Behavioral effects

Reference: Osborn, D., W.J. Eney, and K.R. Bull, 1983, *The toxicity of trialkyl lead compounds to birds*, Environ. Pollut. 31A:261-275. As cited in Eisler (1987)

QCE: 2.8 mg/kg-day (0.2 mg/day)/0.070 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	6 groups/ group sex not specified
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic study
Q ₃	2	2	2	LOAEL endpoint
U	3	3	3	Limited information: organoform of lead could impact toxicity
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.8	2.8	2.8	QCE = quantified critical endpoint
TRV	0.08	0.04	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.08	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC:	Manganese CAS 7439-96-5			
Test Organisms:	Chicken (Omnivore, Order-Galliformes)			
Exposure Medium:	Diet			
Test Endpoint:	NOAEL	Minimum requirement for growth and reproduction		
Reference:	Leeson, S., and J.D. Summers, 1982, <i>Effect of High Dietary Levels of Supplemental Zinc, Manganese, Copper, or Iron on Broiler Performance to Three Weeks of Age and Accumulation of These Minerals in Tissue and Excreta</i>, Nutrition Reports Int. 591-599. Offiong, S.A., and S.M. Abed, 1980, <i>Fertility, Hatchability and Malformations in Guinea Fowl Embryos as Affected by Dietary Manganese</i>, <u>British Poultry Sci.</u> 21:371-375.			
QCE:	1262 mg/kg-day	(880 mg/kg food)*(0.717 kg food/day-bird)*(1 bird/0.5kg)**		
<hr/>				
Adjustment Factors (AF)		Justification for adjustment factor		
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals, limited variability
Q₁	1	1	1	Ecologically relevant endpoint
Q₂	1	1	1	Subchronic study, but not adjusted since this concentration identified as minimum requirement.
Q₃	1	1	1	NOAEL endpoint
U	1	1	1	Study results consistent with other studies in chickens and guinea fowl
Total AF	1.00	2.00	3.00	R * I * Q₁ * Q₂ * Q₃ * U = Total AF
QCE (mg/kg-day)	1262	1262	1262	QCE = quantified critical endpoint
TRV	1,262.00	631.00	420.67	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1262.00	Test organism is in the same order and trophic level as the functional group members	none
2	631.00	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	420.67	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

** Ingestion rate and BW specified in Table II of the Leeson article.

COPC:	Mercury (Organic)
Test Organisms:	Pheasants (Omnivore, Order-Galliformes)
Exposure Medium:	gelatin capsule
Test Endpoint:	AEL - decreased reproductive ability
Reference:	McEwen, L.C., et al., 1973. "Mercury-Wildlife Studies by the Denver Wildlife Research Center", In <i>Mercury in the Western Environment</i> , D.R. Buhler, Ed., Oregon State University, Corvallis, OR, p. 146-156
QCE:	0.64 mg/kg-day 20 mg/kg Ceresan M ^R (mercury fungicide) the 0.64 mg/kg-day was specified by article for a 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Not a large sample, three male and female pheasant pairs.
Q ₁	1	1	1	Endpoints included the # of eggs laid, fertile, hatched and alive chicks. Ecologically relevant endpoint.
Q ₂	2	2	2	Subchronic exposure (30 days)
Q ₃	3	3	3	Adverse effect level
U	2	2	2	Only 1 dosage and control, small number of samples, and NOAEL not established. Author mentions that the capsule dosage is lower than what a wild bird would be estimated to ingest feeding on seeds.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.018	0.0089	0.0059	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	none
2	0.0089	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.0059	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Mercury (Organic) CAS 7439-97-56 Don't use this one
Test Organisms: Goshawk (Carnivore, Order-Falconiformes)
Exposure Medium: Diet
Test Endpoint: FEL-1 Lethal dose
Reference: Borg, K., Erne, E. Hanco, and H. Wanntorp, 1970, *Experimental Secondary Methyl Mercury Poisoning in the Goshawk (Accipiter G. gentilis L.)* Environmental Pollution, 1:91-104.
QCE: 0.64 mg/kg-day Authors reported a total estimated Hg intake of 20 mg for each of 3 animals, over various survival times. The final weight of each animal at the 13 mg/kg dietary level was used to derive individual daily doses, which were averaged.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Small test population, but relatively low variation between individuals and sexed (CV<10%)
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic duration
Q ₃	3	3	3	FEL based on lethality
U	3	3	3	Old study, inappropriate design for risk assessment
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	AV310
2	0.009	Test organism is in a different order and same trophic level from the functional group members	AV322, AV333, AV342
3	0.006	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

COPC:	Mercury (Organic) CAS 7439-97-56		
Test Organisms:	Pheasant (Omnivore, Order-Galliformes)		
Exposure Medium:	Diet		
Test Endpoint:	LOAEL-r	Reduced egg production, shell thickness, reduced hatchability	
Reference:	Fimreite, N., 1979, <i>Accumulation and Effects of Mercury on Birds</i>, Chapter 22 in <i>The biogeochemistry of Mercury in the Environment</i>, J.O. Nriagu, (ed.), Elsevier/North Holland Biomedical Press, New York.		
QCE:	.18 mg/kg-day	Specified	

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	2	2	2	Subchronic duration (12 weeks)
Q ₃	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.18	.18	.18	QCE = quantified critical endpoint
TRV	.011	.005	.004	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.011	Test organism is in the same order and trophic level as the functional group members	none
2	.005	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	.004	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females tested. Experiment 1 used 10 groups of 10 hatchlings of P.W.R.C. Japanese quail, Experiment 2 used 10 groups of 10 hatchlings U.M.D. Japanese quail. Both experiments had comparable results.
Q ₁	1	1	1	Ecologically relevant endpoint. Reproductive endpoints such as, hatchability, egg size, fertility and egg shell thinning assessed.
Q ₂	1	1	1	Chronic exposure (28 weeks)
Q ₃	1	1	1	NOAEL
U	1	1	1	Well designed study. Multiple dose levels (0, 2, 4, 8,16,& 32 ppm) with both NOAELS and LOAELS established. 4 ppm Hg as HgCl ₂ .
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.47	0.47	0.47	QCE = quantified critical endpoint
TRV	0.47	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.47	Test organism is in the same order and trophic level as the functional group members	none
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Mercury (Inorganic)**

Test Organisms: Chickens (Omnivore, Order-Galliformes)

Exposure Medium: Oral in drinking water

Test Endpoint: NOAEL

Reference: Thaxton, P., L.A. Cogburn, and C.R. Parkhurst, 1973. *Dietary mercury as related to the blood chemistry in young chickens*. Poultry Science 52:1212-1214 (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC)

QCE: 10.1 mg/kg-day (125mg/L)*(6.67E-2 L H₂O/day)/1.2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results were inconsistent, however a similar study by Parkhurst and Thaxton, 1973 ^a reported toxic effects in young boilers at 250 ppm (similar study) including growth reduction, decreased feed and water efficiencies, alterations in the sizes of certain organs, immunosuppression, & mortality at 250 ppm as LOAEL.
Q ₁	1	1	1	Study determined effects of dietary Hg on plasma levels of glucose, total protein, total lipids and other blood chemistry. Endpoint is possible in receptor in the field.
Q ₂	2	2	2	Subchronic exposure (6 weeks)
Q ₃	1	1	1	NOAEL (125 ppm see discussion above)
U	2	2	2	Adequate numbers of test animals, 120 young chickens at each 5 dose levels. Reasonable design. Multiple doses assessed (0, 5, 25, 125, 250 ppm) and NOAEL established but no LOAEL and results were inconsistent. Administered as HgCl ₂ in drinking water.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.1	10.1	10.1	QCE = quantified critical endpoint
TRV	1.26	0.63	0.42	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.26	Test organism is in the same order and trophic level as the functional group members	none
2	0.63	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.42	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC:	Mercury (organic)		
Test Organisms:	American black duck (Herbivore, Order-Anseriformes, <i>Anas rubripes</i>)		
Exposure Medium:	Oral in diet (mash)		
Test Endpoint:	Adverse effect - significantly decreased reproduction, elevated tissue levels.		
Reference:	Finley, M.T. and R.C. Stendell, 1978. "Survival and reproductive success of black ducks fed methylmercury", Environmental Pollution, 16:51-64		
QCE:	3 mg/kg-day	(3 ppm Hg fed as methylmercury dicyandiamide)	(3mg/kg food * 0.062 kg food/day)/(1.1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variability appears average.
Q ₁	1	1	1	Clutch size, egg production, # of eggs incubated, hatchability and survival of ducklings.
Q ₂	1	1	1	Chronic exposure (28 weeks)
Q ₃	3	3	3	Adverse effect level (reduced reproduction success)
U	3	3	3	No NOAEL established and only 1 dose level and control. 13 pairs of 1 year old ducks in each group, juveniles also tested.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3	3	3	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: Nickel CAS 7440-02-0
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Growth
Reference: Weber, C.W., and Reid, B.L., 1968, *Nickel toxicity in growing chicks*, *J. Nutr.* 95:612-616.
QCE: 37 mg/kg-day 500 ppm in diet converted to a dose using an estimated ingestion rate* of 0.037 kg/day and a body weight of 500 g from the study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic toxicity studies with adequate numbers of animals
Q ₁	1	1	1	No endpoint observed
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	3	3	3	Older study, reproductive endpoints not evaluated
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	37	37	37	QCE = quantified critical endpoint
TRV	6.17	3.08	2.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.17	Test organism is in the same order and trophic level as the functional group members	none
2	3.08	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.06	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: Nickel CAS 7440-02-0
Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Egg production, hatchability, duckling survival; hematological parameters
Reference: Eastin, W.C., Jr. and O'Shea, T.J., 1981, *Effects of Dietary Nickel on Mallards*, J. Toxicol. Environ. Health 7(6):883-892.
 White, D.H., and M.P. Dieter, 1978, *Effects of Dietary Vanadium in Mallard Ducks*, Journal of Toxicol. and Environ. Health, 4:43-50.
QCE: 140 mg/kg-day (800mg/kg food)*(0.205mg/day*)/1.17 kg BW
 **

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity study; variability not addressed
Q ₁	1	1	1	No endpoint observed
Q ₂	2	2	2	Subchronic study
Q ₃	1	1	1	NOAEL endpoint
U	2	2	2	Reproductive endpoints evaluated, no LOAEL identified.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	140	140	140	QCE = quantified critical endpoint
TRV	17.50	8.75	5.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.50	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	8.75	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	5.83	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

*Birds on 800ppm diet ate 15% more food than the 178g/day of the controls = 205g

**Body weight is indicated in the 1978 White and Dieter study.

COPC: Thallium CAS 7440-28-0
Test Organisms: Golden eagle (Carnivore, Order-Falconiformes)
Exposure Medium: Gelatin capsule
Test Endpoint: Different trophic categories and orders Barely survived; no follow-up
Reference: Bean, J.R. and R.H. Hudson, 1976, "Acute oral toxicity and tissue residues of thallium sulfate in golden eagles (*Aquila chrysaetos*)," Bulletin of Environmental Contamination and Toxicology, 15(1):118-121.
QCE: 49 mg/kg-day 60 mg/kg, corrected for % T1

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Few birds, high doses, short duration
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	3	3	3	Acute duration
Q ₃	3	3	3	FEL for survival
U	3	3	3	Study is old, with an inappropriate design for risk assessment
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	0.60	0.30	0.20	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.60	Test organism is in the same order and trophic level as the functional group members	AV310
2	0.30	Test organism is in a different order and same trophic level from the functional group members	AV322, AV333, AV342
3	0.20	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Very old study, doses and effects poorly characterized, only high doses and lethal endpoints considered
Q ₁	1	1	1	Ecologically relevant endpoint
Q ₂	3	3	3	Acute duration
Q ₃	3	3	3	FEL for lethality
U	3	3	3	Very old study, poorly designed and analyzed
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.4	1.4	1.4	QCE = quantified critical endpoint
TRV	0.02	0.01	0.01	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.02	Test organism is in the same order and trophic level as the functional group members	none
2	0.01	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.01	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

****note-in the article the units on the 12 were just mg/kg...it was assumed that that meant kg of food.**

COPC: Vanadium (Vanadyl sulfate) CAS 27774-13-6(sulfate)
Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Growth and egg production
Reference: Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.
QCE: 1.7 mg/kg-day 25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q ₁	1	1	1	Endpoint ecologically relevant
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	1	1	1	Multiple doses evaluated, good statistical analysis of data
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.85	0.43	0.28	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.85	Test organism is in the same order and trophic level as the functional group members	none
2	0.43	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.28	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**FI=0.0582(BW)0.651 cited in EPA Wildlife Exposures Handbook

COPC: Vanadium (Vanadyl sulfate) CAS 7440-62-2
Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: Diet
Test Endpoint: NOAEL Altered lipid metabolism
Reference: White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.
QCE: 1.0 mg/kg-day 10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q ₁	0.5	0.5	0.5	Ecological relevance of endpoint questionable
Q ₂	2	2	2	Subchronic duration
Q ₃	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442